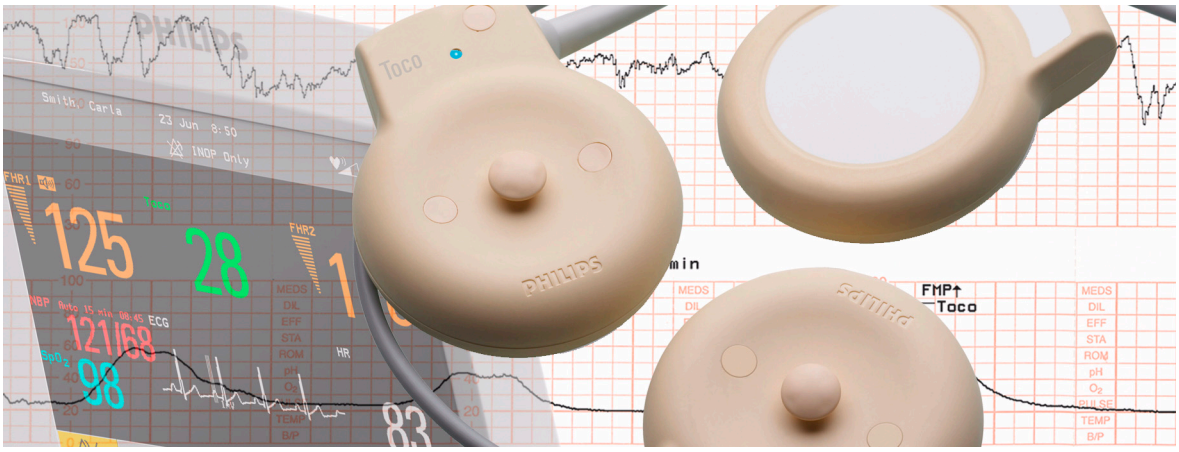
Avalon Smart Transducers



The Philips Avalon family of fetal monitoring products provides cutting edge solutions for fetal/maternal monitoring, setting new standards in performance, reliablity, flexibility, and ease of use. In developing its new generation of fetal monitors, Philips has embraced a new design philosophy that has allowed new possibilities for the monitoring system. Here, Avalon Smart Transducers play a key role.

Traditional Design Approach and Limitations

Up to now, traditional fetal monitoring systems have been designed in such a way that the transducers provide the raw measurement data to the fetal monitor, which then processes these signals via a dedicated channel in the fetal monitor.

This approach has a number of limitations:

- As the analog-to-digital conversion, and subsequent processing of raw signals acquired by the transducer is carried out in the monitor, there is a relatively long analog signal path until the data is processed, which could have consequences such as an increased susceptibility to external interference.
- Different measurements are handled by different hardware components within the fetal monitor. Each socket on the monitor accepts only the matching transducer for that measurement channel. This makes it restrictive in that the user must take care to ensure that the transducer for a particular measurement is connected to the correct, dedicated socket.
- Adding further measurements involves modifying the fetal monitor hardware (for example, installing new measurement-specific boards). This also makes adding new measurements in the future difficult, and the total number of measurements is limited by what physically fits into the monitor.

Flexible, Modular Design from Philips: The Smart Approach

Philips has taken a new approach when designing the new Avalon fetal monitors and their Smart Transducers. Instead of letting the fetal monitor

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perform the processing of measurement data, the Avalon Smart Transducers take care of this. Each transducer is equipped with its own 'brain', a central processing unit (CPU) and signal processing board. As the processing power for a measurement is within the transducer itself, adding a transducer does not place an additional performance burden on the monitor, but rather adds to the processing power of the whole system. So even when monitoring triplets, for instance, there is no compromise in performance, as each fetal heart rate measurement has its own, dedicated signal processing.

Signal acquisition, analog-to-digital conversion and subsequent real-time signal processing are all done in the transducer, then the result is sent to the fetal monitor for display or to be recorded. The fetal monitor accepts signals from any Smart Transducer, which can be connected to any of the pink fetal sensor sockets.

The advantages of "being Smart" are clear:

Very Short Analog Signal Path

The very short analog signal path within the Smart Transducer means that the signals are much less susceptible to interference.

Digital Signal Transmission

Analog-to-digital conversion is done much closer to the source, in the Smart Transducer, so that only digital signals are transmitted to the fetal monitor. Digital signal transmission offers a better signal-to-noise ratio, better reliability and therefore enhanced performance.

Modular Measurements

Each Smart Transducer can be regarded as a measurement module which can be attached to the monitor to provide patient data. You simply take a transducer for the measurement you want, and connect it to the monitor. To add parameters, for example, a second or third fetal heart rate, you just plug in the required additional transducers.

This also means that new measurements developed in the future can be added easily by making a new Smart Transducer, with no need to change the fetal monitor hardware.

Integrated Measurements

Smart Transducer technology even allows several measurements to be integrated into one transducer, making monitoring more flexible, and reducing the number of transducers required. For example, the Toco+ transducer has an integrated front-end which is capable of measuring intra-uterine pressure (IUP) and maternal and fetal ECG, in addition to external Toco measurements.

Triplets Monitoring

Thanks to Smart Transducer technology, Philips can now offer the ability to monitor and document up to three fetal heart rates externally using ultrasound, the very first such solution using a single fetal monitor. See the application note "Monitoring Triplets" for more details.

Smart Means Convenient

Avalon Smart Transducers are designed to make life simpler and more convenient, with an easy use and maintenance concept for cost-effective long-term ownership.

Standardized Connectors

All Avalon Smart Transducers have a standardized, D-shaped, pink connector that allows easy connection to any of the corresponding pink fetal sensor sockets on the fetal monitor, for simple "plug-and-play" convenience. The fetal monitor allocates a channel for the measurement automatically.

Fetal heart rate measurements are labeled in the order in which you plug in the transducers for those measurements. It does not matter which fetal sensor socket you use, as the monitor allocates a channel automatically. For instance, when monitoring triplets, the first transducer you connect is automatically allocated a channel, and the measurement is labelled FHR1, the second FHR2, and the third FHR3.

If you need to disconnect the transducers measuring the FHR temporarily, with the intention to continue monitoring after the temporary break (for example, if the mother needs to go to the bathroom), it is important that you reconnect the transducers in the same order as you originally connected them to make sure the measurement labels remain consistent.

The remote event marker and the Avalon CTS Cordless Fetal Transducer System also share the same standardized connectors.

Standardized Cable

All Smart Transducers also share the same type of cable, which is replaceable, ensuring the transducers have a very long effective working life. The new cable kit comes complete with a new sealing gasket, making sure your Smart Transducers remain watertight. This is another example of Philips' commitment to making your life simpler and reducing the overall cost of ownership.

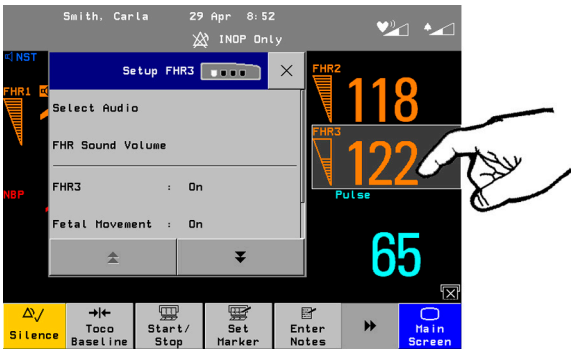
Two-Way Communication

Smart Tranducers allow bi-directional communication with the fetal monitor over a serial bus protocol. For example, this technology allows easy transducer identification using the **Finder LED**.

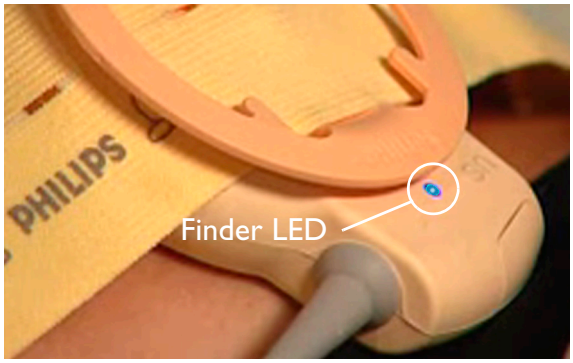
When you touch a measurement numeric on the screen, the setup menu for that measurement opens. The fetal sensor socket to which the transducer for this measurement is connected is identified by the transducer position indicator in the blue setup menu header: for FM20/30; for FM40/50.

When monitoring multiple fetal heart rates, the need may arise to reposition the ultrasound transducers relatively often compared to when monitoring a single fetus. To allow rapid transducer identification, and therefore correspondingly quick transducer repositioning, each transducer is equipped with a **Finder LED**.

Touching a FHR numeric on the screen...



...illuminates the bright, blue Finder LED on the corresponding transducer.



Transducer Finder LED

This allows you to identify at a glance which transducer is monitoring which heart rate channel, making repositioning the transducer quick and easy.

Please refer to the application note, "Monitoring Triplets", for further information about monitoring multiple fetal heart rates using Avalon Smart Transducers.

Ergonomic Design

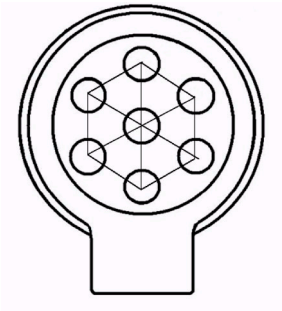
The Smart Transducers are ergonomically designed for maximum patient comfort.

Advanced Technology

Avalon Smart Transducers employ advanced technology unique to Philips, which provides optimal performance.

Optimal Ultrasound Crystal Placement

Smart Ultrasound Transducers employ **seven ultrasound crystals** in an optimal geometric configuration. The crystals are located six around the circumference and one in the center. The crystals are placed on the corners of equilateral triangles. This configuration allows the coverage area to be homogenous, or of equal signal strength throughout, providing an optimum solution in terms of cost, reliability and performance.



7 crystals: optimal placement, homogenous signal

The more homogenous the signal is, the greater its accuracy and ability to provide an reliable signal, thus reducing the number of times the clinician needs to reposition the transducer. Using more than seven crystals (for example nine) within a transducer, means that there are no longer equidistant lines between the crystals, and the triangles created are isosceles triangles. This configuration is unlikely to provide as homogenous a signal. Extensive research has shown that the Philips configuration of 7 crystals provides an optimal solution, and outperforms configurations employing more crystals, so this is a true case of "less is more". And fewer crystals also means lower ultrasound energy.

Cross-Channel Verification

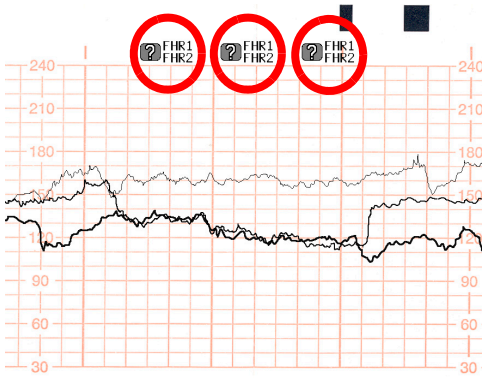
Avalon Smart Transducers allow all monitored heart rates to be compared with each other through the monitor's **Cross-Channel Verification** (CCV) feature. This can help significantly to reduce the possibility of mistaking one heart rate for another, for example, the maternal heart rate (MHR) for the FHR.

As a matter of course, we recommend to also monitor the maternal pulse via SpO_2 to avoid the possibility of mistaking the maternal heart rate (MHR) for the FHR.

CCV indicates when the same heart rate is being recorded by different transducers. On the screen, the coincidence indicator ? is displayed next to the numeric on the screen.

Coincidence Indication on the Screen

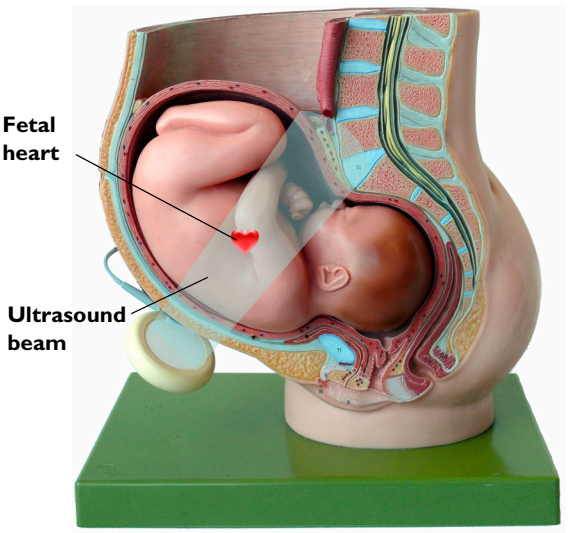
...and ? is repeatedly printed on the trace after about 30 seconds after detecting the coincidence, showing which heart rate channels are coinciding.



Coincidence Indication on the Trace for Triplets

CCV compares all fetal and maternal heart rates continuously and indicates when multiple channels are picking up the same signal. This means that even when monitoring multiple fetal heart rates and the maternal heart rate simultaneously, CCV will compare the values from all fetuses and each of these values with the maternal heart rate.

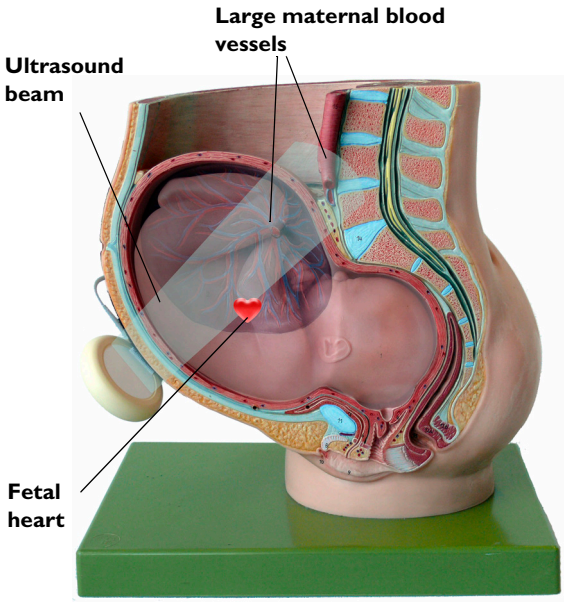
The following simulated picture shows the ultrasound transducer well positioned with respect to the fetal heart.



However well you think you have positioned the ultrasound transducer, CCV gives you added assurance that the fetal heart is the signal source for the monitored heart rate. When the maternal heart rate and fetal heart rate are being monitored, CCV will alert you when the values could be from the same source.

This may happen following fetal or maternal movement, where the fetal heart is no longer fully within the ultrasound beam, and the transducer is

picking up a signal from another source, most likely from another fetal heart (when monitoring multiples) or from a large maternal blood vessel as shown in the simulated picture below.



Note: Be aware that a maternal heart rate trace can exhibit features that are very similar to those of a fetal heart rate trace, even including accelerations and decelerations. Do not rely solely on trace pattern features to identify a fetal source.

CCV technology helps reduce potential legal liability associated with continuing to monitor an incorrect heart rate.

When CCV detects coinciding heart rate signals, you are alerted within approximately 60 seconds to check the traces and potentially reposition the transducers as appropriate to detect all monitored FHRs correctly. If necessary, identify the FHRs using independent means, such as a stethoscope or an ultrasound scanner.

Trace Separation

The baselines of multiple FHR traces are often very similar, and when this occurs, independent trend interpretation can be challenging. To ensure that the three heart rates are easily distinguishable, Avalon Smart Transducers and fetal monitors employ the **Trace Separation** feature which separates the baselines on the recording. You can choose to separate the baselines on the recorder print-out by an offset of 20 bpm, so that the trace for FHR2 is shown 20 bpm higher than it really is, and the trace for FHR3 is shown 20 bpm lower than it really is. The value for the fetal heart rate displayed on the screen is, of course, the real fetal heart rate.

You can turn off the trace separation feature and return the FHR trace to its original baseline anytime you wish.

Please refer to the application note, "Monitoring Triplets", for further information about the Trace Separation feature.

Fetal Movement Profile

Avalon Smart Transducers support Philips' Fetal Movement Profile, a parameter provided by Philips fetal monitors, and which has been accepted as an important additional tool for assessing fetal wellbeing.

In use in Europe, the United States and Japan since 1991, Philips Fetal Monitors simultaneously assess fetal heart rate (FHR), fetal gross body movement via the Fetal Movement Profile (FMP) parameter, and uterine activity.

Recordings of fetal movement are increasingly being obtained as part of routine antepartum screenings in obstetricians' offices, clinics and hospitals.

Benefits of the FHR-FMP assessment range from:

- helping clinicians determine the baseline heart rate - especially in difficult-to-interpret traces, to
- predicting and supervising high risk pregnancies which involve a number of fetal disorders, including fetal growth retardation (IUGR).

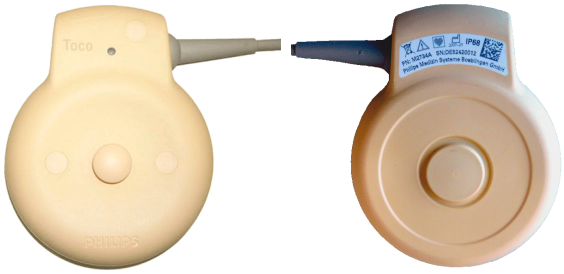
One of the most important benefits of Philips' FMP monitoring is its efficiency and cost effectiveness as an early screening tool.

Clinical trials confirm that the use of Philips Fetal Monitors in routine antepartum screenings reduces the number of patients with "suspicious" FHR test results, thus eliminating their need for additional expensive, second-level testing at the hospital. For the patient, this represents significant savings in time, cost and concern. It also means cost savings for the health care system.

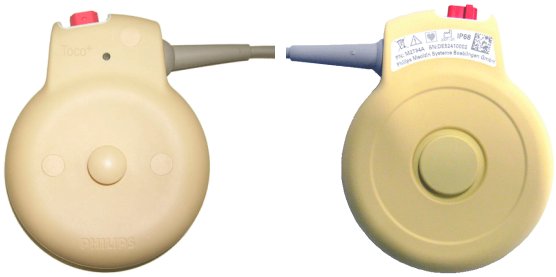
Together with Precision Signal Track and Hold, Cross-Channel Verification and Trace Separation, FMP represents a significant contribution to safety and accuracy in fetal and maternal monitoring.

The Smart Transducer Family

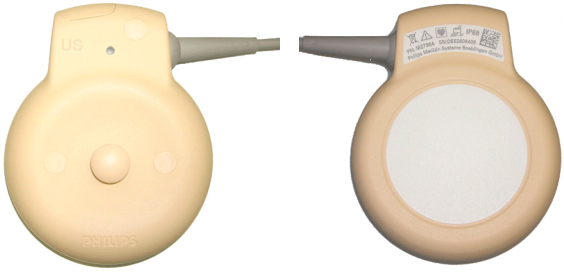
Toco Transducer (M2734A)



Toco+ Transducer for Toco/ECG/IUP (M2735A)



Ultrasound Transducer (M2736A)



Patient Module for ECG/IUP (M2738A)

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